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Hydrologists — Engineers

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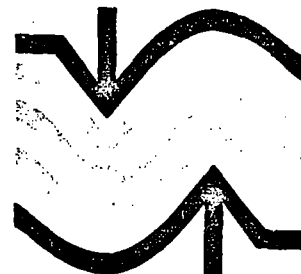


515331

931694

545 Indian Mound  
Wayzata, Minnesota 55391

(612) 473-4224



September 16, 1981



Mr. Michael Convery  
Minnesota Department of Health  
717 S.E. Delaware Street  
Minneapolis, Minnesota 55440

Re: St. Louis Park Groundwater Contamination Study

Dear Mike:

Enclosed is memorandum Number G18-9 entitled, "Collection and Treatment of Gradient Control Well Discharge" for the referenced project.

Respectfully submitted,

EUGENE A. HICKOK AND ASSOCIATES

Eugene A. Hickok, P.E.  
President

crs

Enclosure

cc: Richard Ferguson, MPCA  
Marc Hult, USGS

*revised*

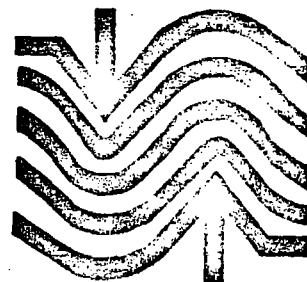
# MEMORANDUM NO. G18-9

DATE: SEPTEMBER 16, 1981

TITLE: ST. LOUIS PARK GROUNDWATER CONTAMINATION STUDY -  
COLLECTION AND TREATMENT OF GRADIENT CONTROL WELL  
DISCHARGE

ABSTRACT: THIS MEMORANDUM IDENTIFIES AND  
ANALYZES THE COLLECTION AND TREATMENT POSSIBILITIES FOR  
GRADIENT CONTROL WELL DISCHARGE. THE MEMORANDUM ADDRESSES  
THE TREATMENT REQUIRED FOR POTABLE USE AND DISCHARGE TO (1)  
SANITARY SEWER; (2) MISSISSIPPI RIVER; (3) MINNEAPOLIS CHAIN  
OF LAKES; AND (4) MINNEHAHA CREEK. THREE PLANS ARE CONSIDERED  
FOR ULTIMATE USE AND/OR DISPOSAL OF GRADIENT CONTROL WELL  
DISCHARGE. COST ESTIMATES ARE INCLUDED FOR THE THREE PLANS  
CONSIDERED. THIS MEMORANDUM REPRESENTS COMPLETION OF TASKS  
4010, 4030, 4050, 4060, 4080 AND 4100.

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ST. LOUIS PARK GROUNDWATER CONTAMINATION STUDY  
COLLECTION AND TREATMENT OF GRADIENT CONTROL WELL DISCHARGE

A. INTRODUCTION

This memorandum identifies collection and treatment possibilities for the water discharged from gradient control wells which may be implemented to remedy ground water contamination in St. Louis Park. Polynuclear aromatic hydrocarbons (PAH) are the contaminants of primary concern.

Gradient control wells are being considered for removal of the most severely contaminated water in the Mt. Simon-Hinckley, Prairie du Chien-Jordan, St. Peter, Platteville and Middle Drift aquifers which presently serve as ground water sources for the City of St. Louis Park and/or private industries.

As backup material for the identification of collection and treatment possibilities for water discharges from gradient control wells, reference should be made to the following memorandums:

G18-5: Alternatives for Ultimate Disposition

G18-6: Gradient Control Well Discharge Quantity

G18-8: Gradient Control Well Discharge Quality

A brief summary of the above referenced memorandums follows.

Water discharged from gradient control wells could be used for potable water purposes or discharged into locally or regionally draining surface waters. If used for potable purposes, the City of St. Louis Park would be the logical user. If discharged to waste, the alternative discharge points are the sanitary sewer, Mississippi River, Minneapolis Chain of Lakes or Minnehaha Creek.

The gradient control well discharge quantities proposed to remedy the St. Louis Park ground water contamination problem were determined previously and summarized in Task 2060. The location of the proposed gradient control wells is shown in Figure 1 and the corresponding average discharge rates are summarized in Table 1.

Gradient control well quality projections were previously determined and presented in Memorandum G18-8, "Gradient Control Well Quality Projections." These quality projections are summarized in Table 2 and have been used in conjunction with the quantity projections as the basis for evaluating treatment and ultimate disposal of gradient control well discharge.

Combining the data assembled in Memorandums G18-5, G18-6 and G18-7, Tables 3 and 4 have been developed which summarizes the treatment requirements for gradient control well discharge for each alternative disposal method.

## B. AVAILABLE TREATMENT TECHNIQUES

### 1. Literature Review

Polynuclear aromatic hydrocarbons (PAH) are compounds of two or more aromatic rings, where adjacent rings share two carbon atoms. In the case of St. Louis Park, PAH compounds identified and monitored are listed in Table 5.

Information concerning PAH compounds in surface and ground waters has been studied since the early 1960's. Identification of PAHs dates back to the 1940's when solubility ranges for phenanthrene (Ph) and benzo(a) pyrene (B(a)P) were derived (David, 1942).

Table 1

## GRADIENT CONTROL WELL PUMPING RATES

<u>Aquifer</u>	<u>Plan</u>	<u>Well</u>	<u>Discharge (gpm)</u>
Mt. Simon-Hinckley	1	SLP 11†	600
	2	R-W23*	300
		R-W38*	300
	3	RW2*	600
Prairie du Chien-Jordan	1	SLP 10,15 (combined)	800
		Park Theater (W70)	1000
		SLP 4	800
		Old SLP 1 (W112)	1500
	2	SLP 10,15 (combined)	800
		Park Theater (W70)	1000
		SLP 4	800
		RW1*	800
St. Peter	1	RW3*	300
Platteville	1	RW4*	150
		RW5*	75
		W100	50
Middle Drift	1	RW6*	125
		RW7*	75
		W2	50

† SLP denotes St. Louis Park municipal well

\* Proposed new well

TABLE 2

Gradient Control Well Discharge Quality  
Projected 20-Year Averages

Aquifer	Plan	Well	PAH Concentrations (ng/l)		
			Highest Carc.	Highest "Other"	"Total" PAH
Mt. Simon-Hinckley	1	SLP 11†	3.	50.	80.
	2	R-W23*	?	?	?
		R-W38*	300	4,000	7,000
	3	RW2*	?	?	?
Prairie du Chien-Jordan	1	SLP 10,15	200	9,000	10,000
		W70	30.	2,000	4,000
		SLP 4	5.	200	300
		W112	30.	3,000	5,000
	2	SLP 10,15	200	9,000	10,000
		W70	30.	2,000	4,000
		SLP 4	5.	200	300
		RW1*	20.	800	1,000
St. Peter	1	RW3*	30.	200	500
Platteville	1	RW4*	9.	2,000	2,000
		RW5*	70.	3,000	5,000
		W100**	30.	2,000	3,000
Middle Drift	1	RW6*	200	1,000	2,000
		RW7*	100	400	1,000
		W2**	200	50.	400

† SLP denotes St. Louis Park municipal well.

\* Proposed new well.

\*\* Estimated initial quality.

NON-RESPONSIVE

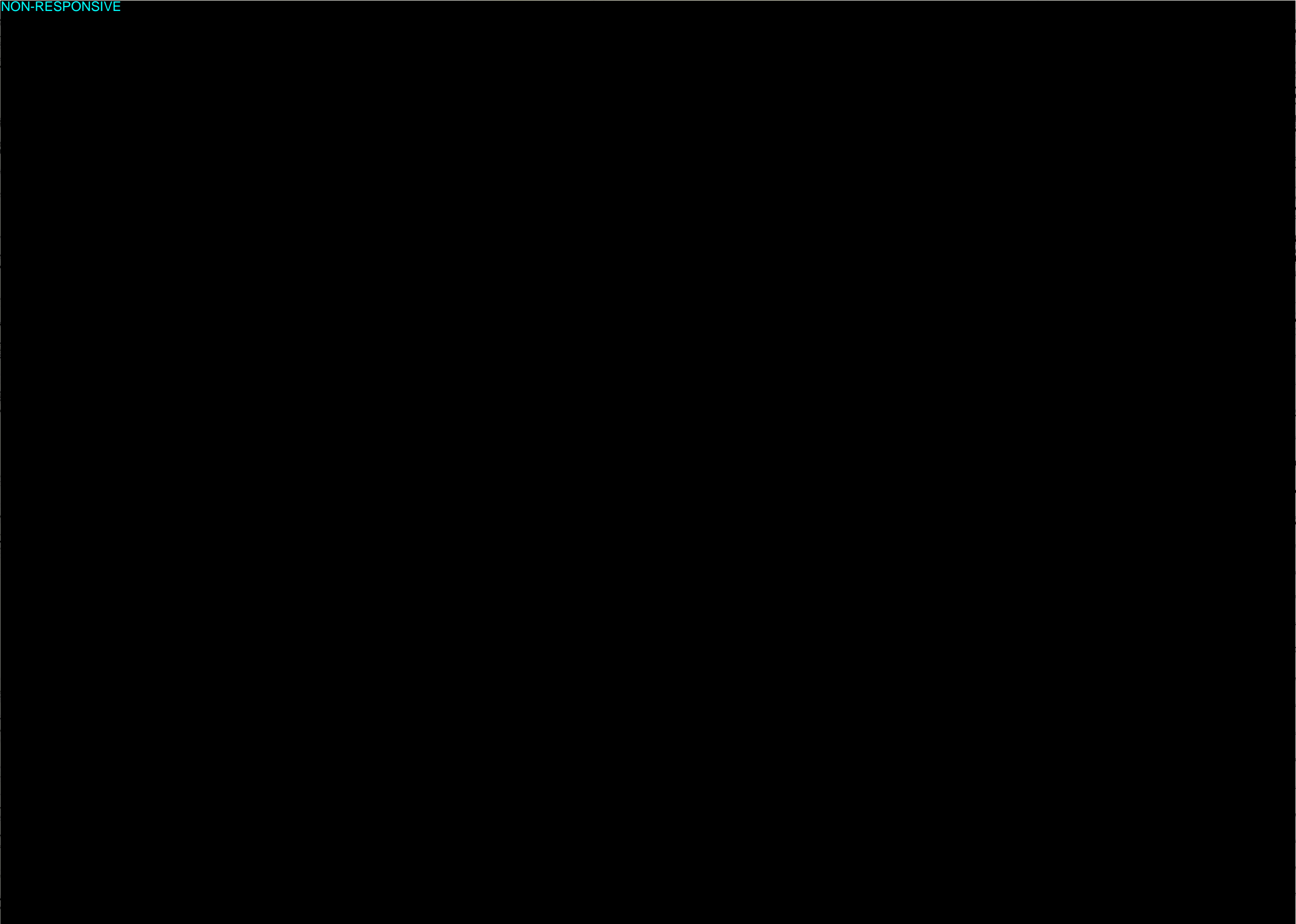


TABLE 3

Treatment Requirements for  
Gradient Control Wells\*

Disposition Alternative	Plan**	Percent PAH Removal Required			
		Potable Criteria		EPA Criteria 10 <sup>-6</sup> Risk	EPA Criteria 10 <sup>-5</sup> Risk
		Carc.	Other PAH	Total PAH	Total PAH
1. Municipal Water Supply	1	95	99	—	—
	2	95	99	—	—
2. Sanitary Sewer	1	0	0	0	0
	2	0	0	0	0
3. Mississippi River	1	0	4	25	0
	2	0	0	0	0
4. Minneapolis Chain of Lakes	1	95	99	99	92
	2	95	99	99	90
5. Minnehaha Creek	1	95	99	99	92
	2	95	99	99	90

\* All wells, excluding pumpout well in drift

\*\* Refers to option for Prairie du Chien-Jordan aquifer

Plan 1 - SLP 4, 10 and 15, W70, Old SLP 1 (W112) - 4100 gpm

Plan 2 - SLP 4, 10 and 15, W70, and RW1 (new well) - 3400 gpm

TABLE 4

Treatment Requirements for  
Pumpout Well in Drift

Disposition Alternative	Percent PAH Removal Required			
	Potable Criteria		EPA Criteria	EPA Criteria
	Carc.	Other PAH	10 <sup>-6</sup> Risk Total PAH	10 <sup>-5</sup> Risk Total PAH
1. Municipal Water Supply	100	100	—	—
2. Sanitary Sewer	100	100	100	99
3. Mississippi River	100	100	100	99
4. Minneapolis Chain of Lakes	100	100	100	100
5. Minnehaha Creek	100	100	100	100

NOTE: Value 100 means &gt;99.5

TABLE 5

## St. Louis Park PAH Compounds

<u>Name</u>	<u>Molecular Weight</u>	<u>Relative Carcinogenic Activity</u>
Anthracene	178	-
Acenaphthene	154	-
Acenaphthylene	152	+
Benzo(a) anthracene	228	+
Benzo(a) pyrene	252	+++
Benzo(g,h,i) perylene	276	-
Benzo(k) fluoranthene	252	-
Chrysene	228	<u>+</u>
Dibenzo(a,h) anthracene	278	+
Fluorene	166	-
Fluoranthene	202	-
Napthalene	128	-
Phenanthrene	178	-
Pyrene	202	-

+++ , ++ Strongly Carcinogenic

+ Carcinogenic

+ Uncertain or Weakly Carcinogenic

- Not Carcinogenic

The first investigations performed to determine the magnitude of PAH compounds and their concentrations were in Germany. At that time no attempt was made to evaluate sampling procedures and analytical procedures nor was any concern placed on the significance of the figures reported.

It was not until the 1970's that work of any significance was performed in the United States regarding PAH compounds. The National Organic Monitoring Survey, Phases I and II (NOMS, 1978) was the first party to attempt to gain comprehensive data on PAH levels in surface and ground waters in the United States. Data collected during this study indicated that fluoranthene (Fl) in concentrations as high as 80 ng/l was present in several supplies. Further investigations (Saxena, 1977; Basu, 1978) revealed PAH compounds ranging as high as 1600 ng/l in certain surface waters.

Studies conducted by Lewis in 1975 on removal of PAH from contaminated waters indicated that conventional treatment processes (clarification) was generally quite effective. Crane et al. (1978) found clarification, i.e., removal of particulates, reduced the PAH level from 50 ng/l to less than 10 ng/l. Crane also found that chlorination and the use of carbon can also affect PAH reduction.

Further studies on the effects of chlorination on PAHs have been investigated by several researchers. A review of these studies indicates that chlorine at dosages ranging from 0.5 mg/l to 100 mg/l and contact times ranging from thirty minutes to 24 hours is effective in reducing various PAH compounds.

Benzo(a) pyrene; (2000 ng/l, highly carcinogenic) for example, treated with a chlorine concentration of 0.5 mg/l for thirteen hours was completely removed (100 percent reduction), whereas if the contact time were reduced to two hours the removal dropped to 50 percent.

It is apparent when reviewing the literature, however, that chlorine, irregardless of concentration and contact time, is "compound specific." At a constant concentration and contact time, one PAH compound may be reduced substantially (90+ percent) whereas another is reduced less than 25 percent.

Furthermore, while data suggests that conventional treatment (including clarification and chlorination) is effective in removing the higher molecular weight PAH, other studies indicate no removal for the lower molecular weight PAH such as phenanthrene, fluoranthene and pyrene.

Factors such as pH, temperature, contact time and chlorine concentration can also have an effect on PAH removal rates. Removal of PAHs through chlorination, as suggested, should not be viewed as a desirable effect, since chlorination does not necessarily remove the PAH moiety. Chlorine can react with PAH synthesizing new compounds which more than likely will remain in solution and which may be more toxic and/or carcinogenic than the original PAH. any backup documentation?

As early as 1962, Borneff and Fischer (1962) demonstrated that activated carbon filtration removed 99 percent of the PAH. Borneff also demonstrated 99 percent removal of PAH using ten

types of activated carbon. Further studies conducted with PAH and activated carbon suggests that activated carbon, whether granular or powdered, is an effective method for removal of PAH. It is well to point out, however, that activated carbon is not effective for the removal of PAH at concentrations less than 20 ng/l (Borneff, 1977).

Although much research and data is available, further investigations to establish the scope of PAH, the treatment methods available and toxicological data is required. While present data suggest that activated carbon is an effective treatment method, further data and information <sup>are</sup> required in order to determine the effects <sup>of chlorination on the toxicity of the PAH compounds.</sup> ~~resulting from the reaction of chlorine and the PAH on their toxicology.~~

## 2. Recent Pilot Plant Study

In view of the rather favorable results obtained using GAC treatment by Borneff and Fisher, E. A. Hickok and Associates conducted a pilot plant study of three (3) treatment techniques for the City of St. Louis Park (1980-1981). Each treatment technique was performed in an attempt to determine PAH removal efficiencies. The three techniques consisted of powdered activated carbon (PAC), granular activated carbon contactors (GAC) and hydrogen peroxide-ultraviolet radiation. The results of the pilot plant study were prepared and submitted to the City of St. Louis Park in April, 1981 in a report entitled, "Drinking Water Treatment and Remedy Evaluation."

The conclusions made as a result of this pilot plant study can be summarized as follows:

1. Additional studies are necessary in order to fully understand the effectiveness of PAC and GAC as a permanent treatment method.
2. Analytical procedures at the present time are unable to detect with any reliability and repeatability at the 1.0 ng/l level (one part per trillion).
3. Carcinogenic PAH compounds appear at relatively low concentrations (SLP 15).
4. PAHs appear to be highly variable in concentrations within a 24-hour period.
5. PAC and GAC are capable of removing 95 to 99 percent of the PAH compounds providing the raw water concentrations are above 20 ng/l.
6. Removal efficiencies are generally better for the non-carcinogenic PAH compounds.
7. Hydrogen peroxide at a concentration of 6 mg/l and 2 mg/l followed by 20 seconds of ultraviolet radiation exposure does not remove PAH compounds.

While additional pilot plant studies are required in order to establish whether or not PAC and GAC are acceptable treatment techniques, the results of the Hickok study and studies by others certainly suggests that these two techniques are capable of removing as much as 99 percent of the raw water PAH compounds.

For the purposes of this memorandum, we have assumed that 99 percent removal is obtainable. Furthermore, the treatment technique to be used to treat gradient control well discharge is GAC (granular activated carbon) if the discharge is used for potable purposes. This <sup>GAC</sup> treatment technique appears, at the present time, to be the best available method for PAH removal and therefore the method recommended for treatment of the gradient control wells.

### 3. Granular Activated Carbon (GAC) Technology

#### GAC System Components

Systems utilizing granular activated carbon are rather simple. In general, they provide for 1) contact between the carbon and the water to be treated for the length of time required to obtain the necessary removal of organics, 2) reactivation or replacement of spent carbon, and 3) transport of makeup or reactivated carbon into the contactors and of spent carbon from the contactors to reactivation or hauling facilities.

#### Selecting Carbon and Plant Design Criteria

Laboratory and pilot plant tests are a mandatory prelude to carbon selection and plant design for water treatment projects. Pilot column tests make it possible to 1) select the best carbon for the specific purpose based on performance, 2) determine the required contact time, 3) establish the required carbon dosage, which, together with laboratory tests of reactivation, will determine the capacity of the carbon reactivation furnace or the necessary carbon replacement costs, and 4) determine the effects of influent water quality variations on plant operation.

One of the principal differences in costs for GAC treatment between water and wastewater is the more frequent reactivation required in water purification due to earlier breakthrough of the organics of concern. In wastewater treatment, GAC may be expected to adsorb 0.30 to 0.55 pounds of COD per pound of carbon before the carbon is exhausted. From the limited amount of data available from research studies and pilot plant tests (most of it unpublished), it appears that some organics of concern in water treatment may break through at carbon loadings as low as 0.15 to 0.25 pounds of <sup>is this COD?</sup> organic per pound of carbon. The actual allowable carbon loading or carbon dosage for a given case must be determined from pilot plant tests. Costs taken from wastewater cost curves which are plots of flow in mgd versus cost (capital or operation and maintenance costs) cannot be applied directly to water treatment. Allowance must be made in the capital costs for the different reactivation capacity needed, and in the operation and maintenance costs for the actual amount of carbon to be reactivated or replaced.

Because the organics adsorbed from water are generally more volatile than those adsorbed from wastewater, the increased reactivation frequency due to lighter carbon loading may be partially offset, or more than offset, by the reduced reactivation requirements of the more volatile organics. The times and temperatures required for reactivation may be reduced due to both the greater volatility and to the lighter loading of organics in the carbon.

From the limited experimental reactivations to date, it appears that reactivation temperatures may be reduced from the 1,650° to 1,750° F. required for wastewater carbons to about 1,500° F. for water purification carbons. The shorter reactivation times required for water purification carbons may allow the number of hearths in a multiple hearth reactivation furnace to be reduced. Also, less fuel may be required for reactivation. These factors must be determined on a case-by-case basis, as already suggested.

Selection of the general type of carbon contactor to be used for a particular water treatment plant application may be used on several considerations indicating the judgement and experience of the engineering designer. The choice generally would be made from three types of downflow vessels:

1. Deep-bed, factory-fabricated, steel pressure vessels of 12-foot maximum diameter. These vessels might be used over a range of carbon volumes from 2,000 to 50,000 cubic feet.
2. Shallow-bed, reinforced concrete, gravity filter-type boxes may be used for carbon volumes ranging from 1,000 to 200,000 cubic feet. Shallow beds probably will be used only when long service cycles between carbon regenerations can be expected, based on pilot plant test results.
3. Deep-bed, site-fabricated, large (20 to 30 feet) diameter, open steel, gravity tanks may be used for carbon volumes ranging from 6,000 to 200,000 cubic feet, or larger.

## GAC Contactors

The advanced wastewater treatment (AWT) experience with GAC contactors may be applied to water purification if some differences in requirements are taken into account. The required contact time must be determined from pilot plant test results. Contactors may be designed for a downflow or upflow mode of operation. Upflow packed beds or expanded beds provide maximum carbon efficiency through the use of countercurrent flow principles. However, upflow beds for water treatment can be used only when followed by filtration due to the leakage of some (1 to 5 mg/l) carbon fines in the upflow carbon column effluent. Downflow carbon beds probably will be used in most municipal water treatment applications.

At the Orange County (California) Water Factory 21, upflow beds were converted to downflow beds which successfully corrected a carbon fines problem. This is one indication at full plant operating scale that carbon fines are not a problem in properly operated downflow contactors.

Single beds or two beds in series may be used. Open gravity beds or closed pressure vessels may be used. Structures may be properly protected steel or reinforced concrete. In general, small plants will use steel, and large plants may use steel or reinforced concrete.

In some instances where GAC has been used in existing water filtration plants, sand in rapid filters has been replaced with GAC. In situations where GAC regeneration or replacement cycles are exceptionally long (several months or years), as may be the

case in taste and odor removal, this may be a solution. However, with the short cycles anticipated for most organics, conventional concrete box style filter beds are not well suited to GAC contact. Their principal drawbacks are the shallow bed depths and the difficulty of moving carbon in and out of the beds. Deeper beds, or contactors with greater aspect ratios of depth to area, provide much greater economy in capital costs. The contactor cost for the needed volume of carbon is much less. Carbon can be moved in water slurry from contactors with conical bottoms easily and quickly and with virtually no labor. Flat-bottomed filters which require labor to move the carbon, unnecessarily add to carbon transport costs. For most, if not all, GAC installations for precursor organic removal, or synthetic organic removal, the use of conventional filter boxes will not be a permanent solution and specially designed GAC contact<sup>ors</sup>~~res~~ should be installed. Contactors should be equipped with flow measur<sup>ing</sup>~~ing~~ devices. Separate GAC contactors are especially advantageous where GAC treatment is required only part of the time during certain seasons, because they then can be used only when needed and bypassed when not needed, possibly saving unnecessary exhaustion and reactivation of GAC. In summary, tremendous cost savings can be realized in GAC treatment of water through proper selection and design of the carbon contactors. The design of carbon contactor underdrains requires experienced expert attention. Good proven underdrain systems are available, but there have been several underdrain failures due to poor design. Some of these same designs have failed in conventional filter service, but they continue to be misapplied. A typical activated carbon contactor installation is illustrated in Figure 2.

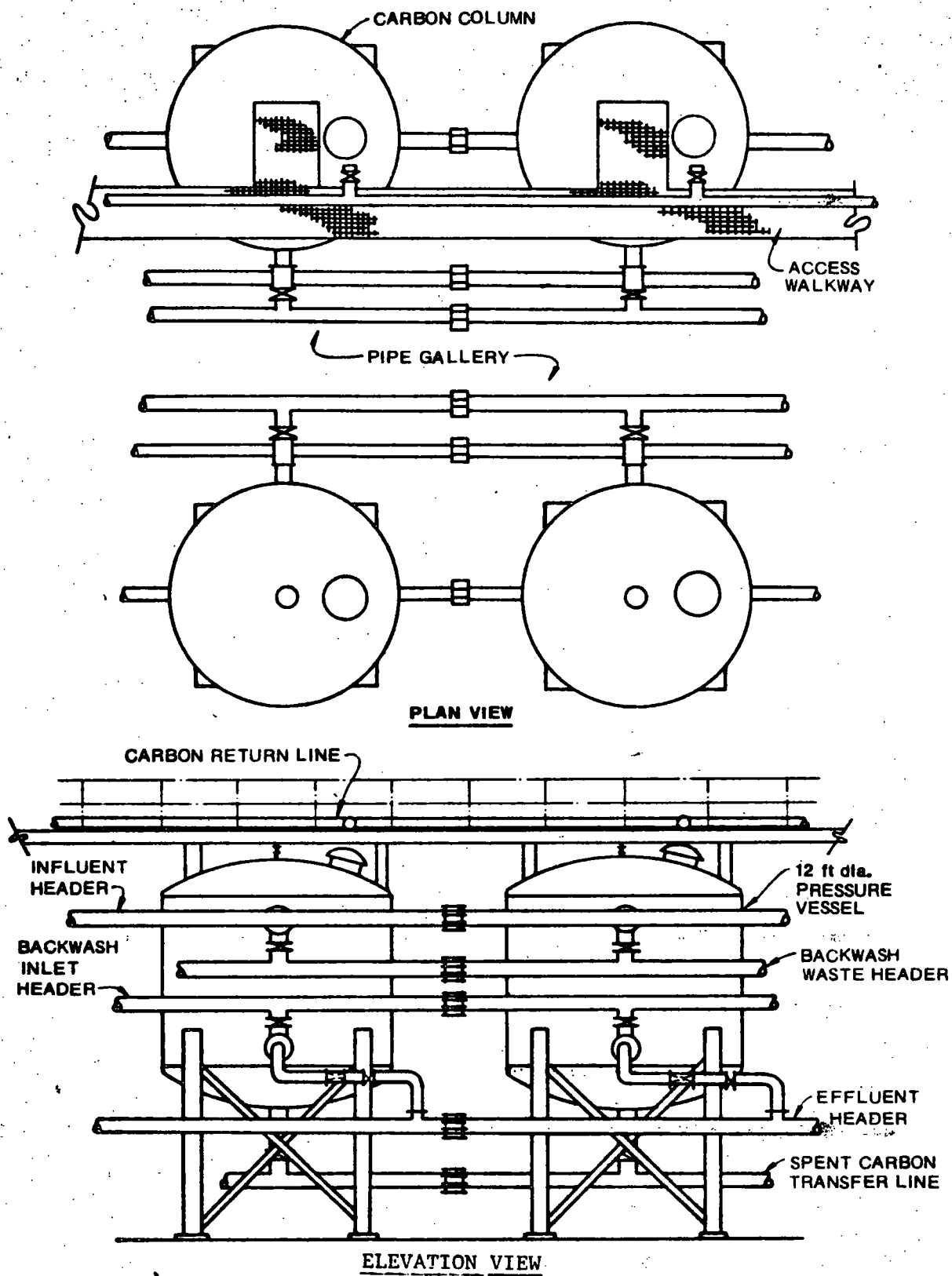


Figure 2

### GAC Reactivation or Replacement

Spent carbon may be removed from contactors and replaced with virgin carbon, or it may be reactivated either on-site or off-site. The most economical procedure depends on the quantities of GAC involved. For larger volumes, on-site reactivation is the answer. Only for small quantities of carbon will carbon replacement or off-site reactivation be economical.

Carbon may be thermally reactivated to very near virgin activity. However, carbon burning losses may be excessive under these conditions. Experience in industrial and wastewater treatment indicates that carbon losses can be minimized (held to 8 to 10 percent per cycle) if the GAC activity of reactivated carbon as indicated by the Iodine Number, is held at about 90 percent of the virgin activity. For removal of certain organics, there may be no decrease in actual removal of organics despite a 10 percent drop in Iodine Number.

### Thermal Reactivation Equipment

GAC may be reactivated in a multiple-hearth furnace, a fluidized bed furnace, a rotary kiln, or an electric infrared furnace.

Spent GAC is drained dry in a screen-equipped tank (40 percent moisture content) or in a dewatering screw (40 to 50 percent moisture) before introduction to the reactivated furnace.

Dewatered carbon is usually transported by a screw conveyor.

Following thermal reactivation, the GAC is cooled in a quench tank.

The water-carbon slurry may then be transported by means of diaphragm slurry pumps, eductors or a blow-tank. The reactivated carbon may contain fines produced during conveyance, and these

finer should be removed in a wash tank or in the contactor.

Maximum furnace temperatures and time of retention in the furnace are determined by the amount (pounds of organics per pound of carbon) and nature molecular weight, or volatility, of the organics adsorbed.

### C. COLLECTION AND TREATMENT ALTERNATIVES

Using the gradient control well system outlined in Task 2030, the water quantity and quality discharged from the gradient control well system outlined in Tasks 2060 and 2050, respectively, and the disposition alternatives as described in Task 4040, it then becomes possible to develop cost-effective schemes for ultimate disposition of gradient control well discharge.

In view of the fact that the City of St. Louis Park has shut down six (6) municipal wells because of PAH contamination, it is logical to use as much of the gradient control well discharge as possible for potable use. It is assumed that with the best technology available (GAC treatment), the gradient control wells effluent can be treated to meet the proposed potable water criteria which are as follows (refer to Memorandum G18-5 for specific details):

Potable Criteria	<u>PAH Limits (ng/l)</u>
Each Carcinogenic PAH	2.8
Each "Other" PAH	28.0
EPA Criteria ( $10^{-6}$ risk)	
"Total" PAH	31.1
EPA Criteria ( $10^{-5}$ risk)	
"Total" PAH	311

Cost estimates for the various alternative disposition methods were developed using the following cost data:

1. GAC Treatment Plant Costs - EPA 600/2-79-162a, Vol. 1, Estimating Water Treatment Costs - Adjusted from October 1978 to January 1982.
2. Energy Costs - Electrical - \$0.05/kw-hr  
Natural Gas - \$0.003/scf
3. Metropolitan Waste Control Commission Sewer Service Charge (if discharged to sanitary sewer)  
  
First 100,000 ft<sup>3</sup> per month \$0.55/100 cf  
Next 900,000 ft<sup>3</sup> per month \$0.52/100 cf  
Next 1,000,000 ft<sup>3</sup> per month \$0.49/100 cf  
Next 1,000,000 ft<sup>3</sup> per month \$0.46/100 cf
4. Well Pump and Motor - \$200/horsepower
5. Force Mains - 4" - \$12.00/L.F.  
6" - \$22.00/L.F.  
8" - \$26.00/L.F.  
10" - \$30.00/L.F.  
12" - \$35.00/L.F.  
18" - \$50.00/L.F.
6. Street Restoration - \$20.00/L.F. (non-congested areas)  
\$40.00/L.F. (congested areas)
7. Jacking - \$200.00/L.F.

Although several cost analyses were performed on various gradient control well disposition alternatives, three (3) are presented herewith. All of the alternatives assume Plan 1 for the Mt. Simon-Hinckley and Plan 2 for the Prairie du Chien-Jordan as the gradient control well system. These three (3) cost alternatives appear to be the best available in terms of dollars as well as supplementing the presently depleted St. Louis Park well source. The cost alternatives are described as Alternatives A, B and C and summarized as follows:

Alternative A treats 2200 gpm for use in the St. Louis Park Water Supply System and discharges 2625 gpm to the sanitary sewer. 4825 gpm

Alternative B treats <sup>450</sup>2200 <sup>2175</sup>gpm for use in the St. Louis Park Water Supply System, discharges 450 gpm to the sanitary sewer and discharges 2175 gpm to the Mississippi River. 4825

Alternative C discharges 4825 gpm to the Mississippi River with no water treated or discharged to the sanitary sewer. 4825 gpm

A detailed description of each alternative follows:

#### Alternative A

<u>Aquifer</u>	<u>Ultimate Use and/or Disposition</u>
Mt. Simon-Hinckley	Use SLP 11 - treat and use for potable use.
Prairie du Chien-Jordan	Use SLP 4, 10 and 15 - treat and use for potable use.  Discharge W70 to sanitary sewer at corner of Lake Street and city limit.  Discharge RW1 to sanitary sewer at corner of Glenhurst and 39th Street.
St. Peter	Discharge RW3 to sanitary sewer at corner of Natchez and 39th Street.
Platteville	Discharge RW4, RW5 and W100 to adjacent sanitary sewers.
Middle Drift	Discharge RW6, RW7 and W2 to adjacent sanitary sewers.

#### Alternative B

<u>Aquifer</u>	<u>Ultimate Use and/or Disposition</u>
Mt. Simon-Hinckley	Use SLP 11 - treat and use for potable use.
Prairie du Chien-Jordan	Use SLP 4, 10 and 15 - treat and use for potable use.

### Alternative B (continued)

<u>Aquifer</u>	<u>Ultimate Use and/or Disposition</u>
	Discharge W70 and RW1 to Mississippi River via 42" RCP at corner of Lyndale and 25th Street.
St. Peter	Discharge RW3 to Mississippi River via 42" RCP at corner of Lyndale and 25th Street.
Platteville	Discharge RW4 and W100 to adjacent sanitary sewers and RW5 to Mississippi River via 42" RCP at corner of Lyndale and 25th.
Middle Drift	Discharge RW6, RW7 and W2 to adjacent sanitary sewers.

### Alternative C

All gradient control well discharge is routed to the Mississippi River for disposition.

Alternative B was developed in order to eliminate the high cost of sewer service charges which would be levied by the Metropolitan Waste Control Commission. A schematic flow diagram of the piping required for discharge of gradient control wells RW1, RW3, RW5 and W70 to the Mississippi River via an existing 42" RCP at the corner of Lyndale and 25th Street is shown in Figure 3.

Alternative C was developed to dispose of all water to the Mississippi River with no treatment of any water. A schematic flow diagram of the piping required for this alternative is shown in Figure 4. *no lengths presented*

Expense estimates of Alternatives A, B and C are summarized in Tables 6, 7 and 8, respectively.

It is apparent that discharge of gradient control wells into the sanitary sewer should be avoided due to the excessive sewer service charge levied by the Metropolitan Waste Control Commission.

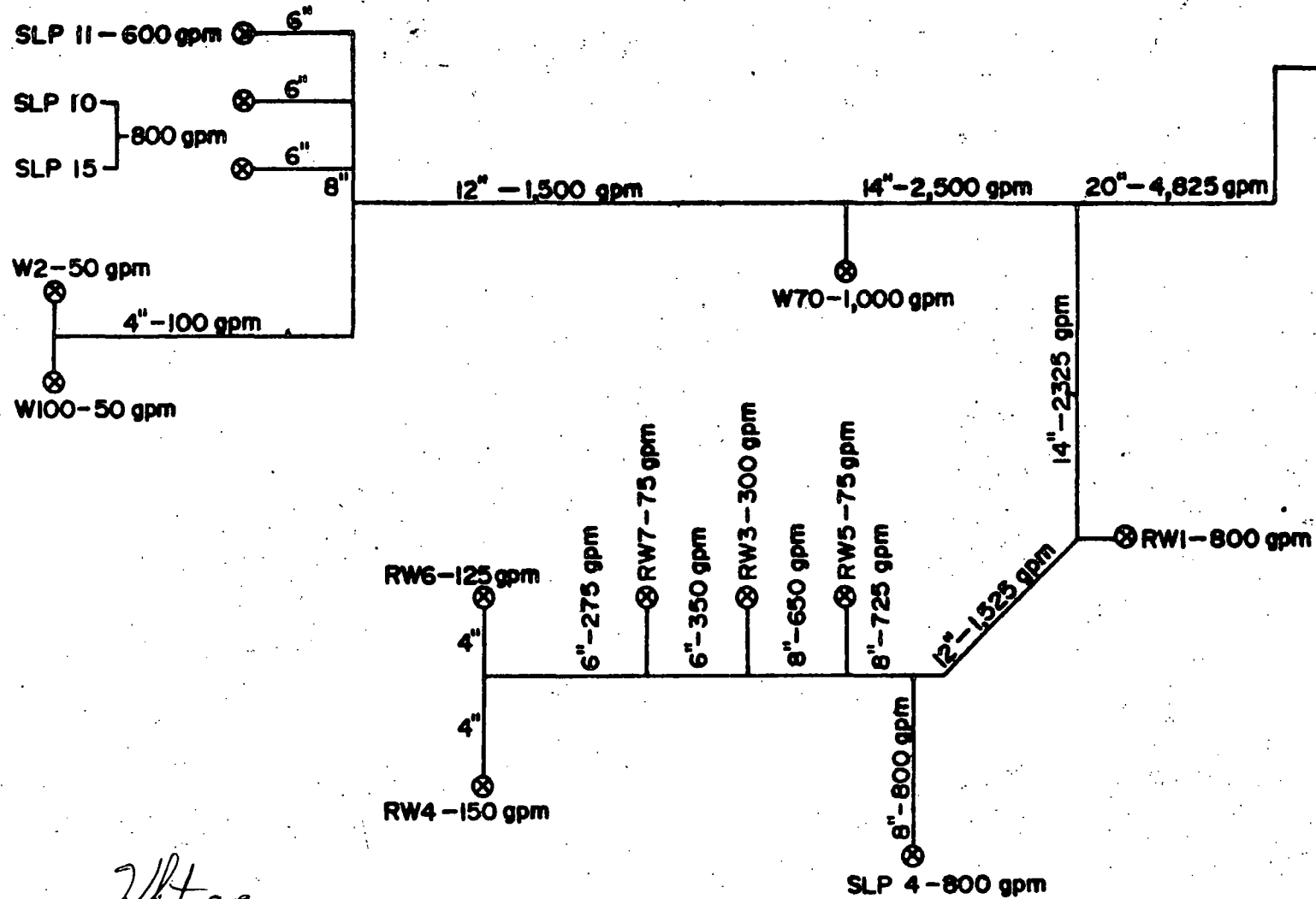
NON-RESPONSIVE



SCHEMATIC FLOW DIAGRAM

Figure 3

ALT. C-DISCHARGE OF ALL GRADIENT CONTROL  
WELLS TO MISSISSIPPI RIVER



EXIST. 42" RCP  
STORM SEWER  
TO MISSISSIPPI  
RIVER

LYNDALA AVE.

SCHEMATIC FLOW DIAGRAM

Figure 4

*What are  
pipe lengths required?*

TABLE 6

Collection and Treatment Alternatives  
Cost Estimates  
Alternative A

<u>Aquifer</u>	<u>Estimated Capital Expense</u>		<u>Yearly Operation<sup>(1)</sup> and Maintenance Costs</u>	<u>Yearly Sewer Service Charge</u>
	<u>Treatment Plant</u>	<u>Pump, Motor, Force Main, etc.</u>		
Mt. Simon-Hinckley	\$1,550,000*	0	\$193,200	0
Prairie du Chien- Jordan	\$3,020,000	\$310,600	\$369,000	\$588,200
St. Peter	0	\$123,000	\$ 8,450	\$107,250
Platteville	0	\$ 46,400	\$ 14,400	\$ 98,650
Middle Drift	<u>0</u>	<u>\$ 51,500</u>	<u>\$ 12,900</u>	<u>\$ 90,040</u>
TOTAL	\$4,570,000	\$531,500	\$597,950	\$884,140

\* Not needed for 20 years +

(1) Includes: Pumping costs, heating costs, normal maintenance and labor costs to operate gradient control wells.

*can these values be brought  
to present worth for comparison?*

TABLE 7

Collection and Treatment Alternatives  
Cost Estimates  
Alternative B

<u>Aquifer</u>	<u>Estimated Capital Expense</u>		<u>Yearly Operation(1) and Maintenance Costs</u>	<u>Yearly Sewer Service Charge</u>
	<u>Treatment Plant</u>	<u>Pump, Motor, Force Main, etc.</u>		
Mt. Simon-Hinckley	\$1,550,000*	0	\$193,200	0
Prairie du Chien- Jordan	\$3,020,000	\$ 842,500	\$376,200	0
St. Peter	0	\$ 156,000	\$ 10,400	0
Platteville	0	\$ 79,400	\$ 16,000	\$ 72,800
Middle Drift	<u>0</u>	<u>\$ 51,500</u>	<u>\$ 12,900</u>	<u>\$ 90,040</u>
TOTAL	\$4,570,000	\$1,129,400	\$608,700	\$162,840

*more sewers required  
than A.*

*save significant  
over A. due to  
Miss. River discharge*

\* Not needed for 20 years +

(1) Includes: Pumping costs, heating costs, normal maintenance and labor costs to operate gradient control wells.

TABLE 8

Collection and Treatment Alternatives  
Cost Estimates  
Alternative C

Aquifer	Estimated Capital Expense		Yearly Operation <sup>(1)</sup> and Maintenance Costs	Yearly Sewer Service Charge
	Treatment Plant	Pump, Motor, Force Main, etc.		
Mt. Simon-Hinckley	0	] \$4,600,000	\$ 26,400	0
Prairie du Chien- Jordan	0		\$182,000	0
St. Peter	0		\$ 14,400	0
Platteville	0		\$ 18,500	0
Middle Drift	<u>0</u>		<u>\$ 18,000</u>	<u>0</u>
TOTAL	0	\$4,600,000	\$259,300	0

(1) Includes: Pumping costs, heating costs, normal maintenance and labor costs to operate gradient control wells.

*no treatment for  
Miss River discharge*

*why so much  
oper.?*

## Summary

The proposed gradient control well system would have a combined discharge of approximately 5,000 gpm. The alternatives for disposition of this water are discharge to the sanitary sewer, Mississippi River, Minnehaha Creek or Minneapolis Lakes, or treatment and potable use in the City of St. Louis Park.

Discharge to Minnehaha Creek or the Minneapolis Lakes requires the water to be treated to levels approximating the drinking water criteria proposed in this study. Therefore, since the City of St. Louis Park requires additional potable water supply, discharge to Minnehaha Creek or the Minneapolis Lakes is not considered a viable option.

Granular activated carbon appears to be the best available treatment method for PAH removal from gradient control well discharge. Based on preliminary pilot plant studies, it appears that this technique can achieve 99 percent removal of PAH compounds. Such removal is sufficient to attain the proposed drinking water criteria for PAH compounds.

Cost analysis indicates that discharge of gradient control water to the sanitary sewer should be minimized principally due to extremely high expense related to sewer service charges.

Discharge of all gradient control well water to the Mississippi River appears at this time to have the minimum cost.

Gradient control well water treatment for potable use would address the present water supply shortage problem of the City of St. Louis Park and at the same time provide a means for removing PAH from the environment. The mode of ultimate disposition of the gradient control water must take into account all of the above considerations.

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